TABLE 1.0.1

HI-STORM FW SYSTEM COMPONENTS

Item	Designation (Model Number)	Versions of Model
Overpack	HI-STORM FW ~~(Includes Standard, Version XL, & Version E)~~	Standard Version XL Version E
	HI-STORM FW UVH**	**
PWR Multi-Purpose Canister	MPC-37~~,~~	Standard
	MPC-32ML~~,~~	Standard
	MPC-37P*~~,~~	CBS
	MPC-44	CBS
BWR Multi-Purpose Canister	MPC-89 ~~(Includes Standard & Version CBS)~~	Standard CBS
Transfer Cask	HI-TRAC VW(Standard)~~,~~	Standard
	HI-TRAC VW Version V~~,~~	Standard
	HI-TRAC VW Version V2	Standard

*MPC-37P qualified for storage in the HI-STORM FW Version E.
**All UVH overpack information is contained in Supplement I to the FSAR.

1.1 INTRODUCTION TO THE HI-STORM FW SYSTEM

This section and the next section (Section 1.2) provide the necessary information on the HI-STORM FW System pursuant to 10CFR72 paragraphs 72.2(a)(1),(b); 72.122(a),(h)(1); 72.140(c)(2); 72.230(a),(b); and 72.236(a),(c),(h),(m).

HI-STORM (acronym for Holtec International Storage Module) FW System is a spent nuclear fuel storage system designed to be in full compliance with the requirements of 10CFR72. The model designation "FW" denotes this as a system which has been specifically engineered to withstand sustained Flood and Wind.

The HI-STORM FW System consists of a sealed metallic multi-purpose canister (MPC) contained within an overpack constructed from a combination of steel and concrete. The design features of the HI-STORM FW components are intended to simplify and reduce the on-site SNF loading and handling work effort, to minimize the burden of in-use monitoring, to provide utmost radiation protection to the plant personnel, and to minimize the site boundary dose.

The HI-STORM FW System can safely store either PWR or BWR fuel assemblies, in the MPCs identified in Table 1.0.1. The MPC is identified by the maximum number of fuel assemblies it can contain in the fuel basket. It should be assumed that any statement or discussion in the FSAR applies to any basket version designed for use with the identified MPC number as specified in Table 1.0.1 unless the basket version is specifically called out in a particular statement or discussion of an MPC. The MPC external diameters are identical to allow the use of a single overpack design, however the height of the MPC, as well as the overpack and transfer cask, are variable based on the SNF to be loaded.

Figure 1.1.1 shows the HI-STORM FW System with two of its major constituents, the MPC and the storage overpack, in a cut-away view. The MPC, shown partially withdrawn from the storage overpack, is an integrally welded pressure vessel designed to meet the stress limits of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NB [1.1.1]. The MPC defines the Confinement Boundary for the stored spent nuclear fuel assemblies. The HI-STORM FW storage overpack provides structural protection, cooling, and radiological shielding for the MPC.

The HI-STORM FW overpack is equipped with thru-wall penetrations at the bottom of the overpack. The exit air passageway is located in the body of the standard lid. The “Version XL” (extra-large) lid and “Domed” lid are variants of the standard lid design with the exit air passageway located at the bottom of the lid near the cask body interface to permit efficient, natural circulation of air to cool the MPC and the contained SNF. The “Version E” overpack is a variant of the standard overpack with an alternate design of the thru-wall penetrations at the bottom of the overpack, and this version uses a designated lid (“Version E lid”) which is similar to the Version XL lid. The HI-STORM FW System is autonomous inasmuch as it provides SNF and radioactive material confinement, radiation shielding, criticality control and passive heat removal independent of any other facility, structures, or components at the site. The surveillance and maintenance required by the plant's staff is minimized by the HI-STORM FW System since it is completely passive and is composed of proven materials. The HI-STORM FW System can be used either singly or as an array at an ISFSI. The site for an ISFSI can be located either at a nuclear reactor facility or an away-from-a-reactor (AFR) location.

2.1.6 Radiological Parameters for Design Basis SNF

The principal radiological design criteria for the HI-STORM FW System are the 10CFR72 §104 and §106 operator-controlled boundary dose rate limits, and the requirement to maintain operational dose rates as low as reasonably achievable (ALARA). The radiation dose is directly affected by the gamma and neutron source terms of the assembly, which is a function of the assembly type, and the burnup, enrichment and cooling time of the assemblies. Dose rates are further directly affected by the size and arrangement of the ISFSI, and the specifics of the loading operations. All these parameters are site-dependent, and the compliance with the regulatory dose rate requirements are performed in site-specific calculations. The evaluations here are therefore performed with reference fuel assemblies, and with parameters that result in reasonably conservative dose rates. The reference assemblies given in Table 1.0.4 are the predominant assemblies used in the industry.

The design basis dose rates can be met by a variety of burnup levels and cooling times. Table 2.1.1a provides the acceptable ranges of burnup, enrichment and cooling time for all of the authorized fuel assembly array/classes. Table 2.1.5 and Figures 2.1.3 and 2.1.4 provide the axial distribution for the radiological source terms for PWR and BWR fuel assemblies based on the axial burnup distribution. The axial burnup distributions are representative of fuel assemblies with the design basis burnup levels considered. These distributions are used for analyses only, and do not provide a criterion for fuel assembly acceptability for storage in the HI-STORM FW System.

Non-fuel hardware, as defined in the Glossary, has been evaluated and is also authorized for storage in the PWR MPCs as specified in Table 2.1.1a.

2.1.6.1 Radiological Parameters for Spent Fuel and Non-fuel Hardware in MPC-32ML, MPC-37 and MPC-89

MPC-32ML is authorized to store 16x16D spent fuel with burnup - cooling time combinations as given in Table 2.1.9. Spent fuel with burnup – cooling time combinations authorized for storage according to the alternative storage patterns shown in Figures 1.2.3 through 1.2.5 (MPC-37) and 1.2.6 through 1.2.7 (MPC-89) are given in Table 2.1.10. Burnup and cooling time combinations in Table 2.1.10 also apply for 10x10J fuel loaded according to heat load regions shown in Table 1.2.4a.

The burnup and cooling time for every fuel assembly loaded into the MPC-32ML, MPC-37 and MPC-89 must satisfy the following equation:

$$Ct = A \cdot Bu^3 + B \cdot Bu^2 + C \cdot Bu + D$$

where,

Ct = Minimum cooling time (years),
Bu = Assembly-average burnup (MWd/mtU),

Table 2.1.3 (continued)

BWR FUEL ASSEMBLY CHARACTERISTICS (Notes 1, 17)

Fuel Assembly Array and Class	**10x10 C**	**10x10 F**	**10x10 G**	**10x10 I**	**10x10 J**	**11x11 A**
Maximum Planar-Average Initial Enrichment (wt.% ^{235}U) (Note 14)	≤ 4.8	≤ 4.7 (Note 13)	≤ 4.6 (Note 12)	≤ 4.8	≤ 4.8	≤ 4.8
No. of Fuel Rod Locations (Note 16)	96	92/78 (Note 7)	96/84	91/79 (Note 18)	96/80 (Note 19)	112/92 (Note 20)
Fuel Clad O.D. (in.)	≥ 0.3780	≥ 0.4035	≥ 0.387	≥ 0.4047	≥ 0.3999	≥ 0.3701
Fuel Clad I.D. (in.)	≤ 0.3294	≤ 0.3570	≤ 0.340	≤ 0.3559	≤ 0.3603	≤ 0.3252
Fuel Pellet Dia. (in.)	≤ 0.3224	≤ 0.3500	≤ 0.334	≤ 0.3492	≤ 0.353~~0~~1	≤ 0.3193
Fuel Rod Pitch (in.)	≤ 0.488	≤ 0.510	≤ 0.512	≤ 0.5100	≤ 0.5149	≤ 0.4705 (Note 21)
Design Active Fuel Length (in.)	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150	≤ 150
No. of Water Rods (Note 10)	5 (Note 9)	2	5 (Note 9)	1 (Note 5)	1	1 (Note 5)
Water Rod Thickness (in.)	≥ 0.031	≥ 0.030	≥ 0.031	≥ 0.0315	≥ 0.0297	≥ 0.03220~~40~~
Channel Thickness (in.)	≤ 0.055	≤ 0.120	≤ 0.060	≤ 0.100	≤ 0.0938	≤ 0.100

TABLE 2.1.10
BURNUP AND COOLING TIME FUEL QUALIFICATION REQUIREMENTS
FOR MPC-37 AND MPC-89

Cell Decay Heat Load Limit (kW)	**Polynomial Coefficients, see Paragraph 2.1.6.1**			
	A	**B**	**C**	**D (Note 1)**
MPC-37				
≤ 0.85	1.68353E-13	-9.65193E-09	2.69692E-04	2.95915E-01
0.85 < decay heat ≤ 3.5	1.19409E-14	-1.53990E-09	9.56825E-05	-3.98326E-01
MPC-89 (Note 2)				
≤ 0.32	1.65723E-13	-9.28339E-09	2.57533E-04	3.25897E-01
0.32 < decay heat ≤ 0.5	3.97779E-14	-2.80193E-09	1.36784E-04	3.04895E-01
0.5 < decay heat ≤ 0.75	1.44353E-14	-1.21525E-09	8.14851E-05	3.31914E-01
0.75 < decay heat ≤ 1.1	-7.45921E-15	1.09091E-09	-1.14219E-05	9.76224E-01
1.1 < decay heat ≤ 1.45	3.10800E-15	-7.92541E-11	1.56566E-05	6.47040E-01
1.45 < decay heat ≤ 1.6	-8.08081E-15	1.23810E-09	-3.48196E-05	1.11818E+00

Notes:

1. For BLEU fuel, coefficient D is increased by 1.
2. For calculation of the minimum cooling time for 10x10J fuel that is loaded in accordance with Table 1.2.4a or Table 1.2.4b, an assembly-average burnup must be increased by 10,000 MWd/mtU and 5,000 MWd/mtU, respectively.

~~1.~~

Table 2.2.3

TEMPERATURE LIMITS

HI-STORM FW Component	**Normal Condition and Design Temperature Limits (°F)**	**Short-Term Events†† Temperature Limits (°F)**	**Off-Normal and Accident Condition Temperature Limits † (°F)**
HI-TRAC VW bottom flange	-	400	700
HI-TRAC VW radial neutron shield	-	311	N/A
HI-TRAC VW radial lead gamma shield	-	600	600
HI-TRAC VW Version V2 NSC steel	-	400	600
HI-TRAC VW Version V2 NSC Holtite-A	-	300	350
Fuel Cladding	752	752 or 1058 (Short Term Operations)††	1058 (Off-Normal and Accident Conditions)
Overpack concrete	300 (See HI-STORM 100 FSAR Appendix 1.D)	572 (on local temperature of shielding concrete)	572
Overpack Lid Top and Bottom Plate	450	450	572
Overpack Inner Shell	475	700	700~~800~~
Remainder of overpack steel structure	350	350	700
Damaged Fuel Isolator	752	932	932

value (i.e., maximum or minimum weight), as appropriate.

b. Lead

Lead is not considered as a structural member of the HI-STORM FW system. Its load carrying capacity is neglected in all structural analysis, except in the analysis of a tornado missile strike where it acts as a missile barrier. Applicable mechanical properties of lead are provided in Table 3.3.5.

c. Fuel Basket Shims

The fuel basket shims (basket shims), as presented on the drawings in Section 1.5, are made of an aluminum alloy to ensure a high thermal conductivity and to ensure stable mechanical properties in the temperature range obtained in the peripheral region of the fuel basket. Nominal mechanical properties for the basket shims are tabulated in Table 3.3.7.

Strictly speaking, the shim is not a structural material because it does not withstand any tensile loads and is located in a confined space which would prevent its uncontrolled deformation under load. The simulation of the shim in the basket's structural model, however, utilizes its mechanical properties of which only the Yield Strength has a meaningful (but secondary) role. Accordingly, in this FSAR, the nominal value of the Yield Strength specified in Table 3.3.7 herein, is set down as a "critical characteristic" for the shim material. The minimum value of the Yield Strength reported in the material supplier's CoC must be at least 90% of the nominal value in the above referenced table to ensure that the non-mechanistic tip-over analysis will not have to be revisited.

d. CBS Bolts and Nuts

The attachment bolts and nuts connecting the continuous basket shims (CBS) to the extended panels of the CBS basket designs, as presented on the applicable drawings in Section 1.5, are made of Alloy X. The nominal mechanical properties for the CBS bolts and nuts are tabulated in Table 3.3.1.

The function of the bolts is to maintain the axial connectivity of the basket panels during normal operations, and they do not experience any significant loads during the applicable mechanical loading scenarios under all conditions.

Table 4.5.31 MAXIMUM COMPONENT TEMPERATURES UNDER VACUUM DRYING OPERATIONS OF MPC-37P		
Component	**Temperature @ Threshold Heat (HBF) °C (°F)**	**Temperature @ Design Maximum Heat (MBF) °C (°F)**
Fuel Cladding	379 (714)	473 (883)
MPC Basket	356 (673)	425 (797)
Aluminum Basket Shims	256 (493)	314 (597)
MPC Shell	145 (293)	160 (320)
MPC Lid[1]	136 (277)	155 (311)

Table 4.5.32 MAXIMUM COMPONENT TEMPERATURES UNDER VACUUM DRYING OPERATIONS OF MPC-44		
Component	**Temperature @ Threshold Heat (HBF) °C (°F)**	**Temperature @ Design Maximum Heat (MBF) °C (°F)**
Fuel Cladding	368 (694)	444 (831)
MPC Basket	354 (669)	430 (806)
Aluminum Basket Shims	258 (496)	302 (576)
MPC Shell	210 (410)	237 (459)
MPC Lid[1]	99 (507)	104 (219)

1 Maximum section average temperature is reported.

a. Assemblies must meet the dimensional requirements for the applicable array/class.

b. If fuel is to be loaded using one of the loading patterns where requirements differ between basket cells, the pattern should be identified, and each assembly should be shown to meet the applicable requirements for the designated basket cell. This may include:

i. Assembly decay heat (including any decay heat contribution of non-fuel-hardware located in the assembly, and any adjustments for fuel lengths) meets the decay heat limit of the cell

ii. Assembly cooling time meets the cooling time limit established for the specific assembly and cell location. For MPC-37, ~~and~~ MPC-89, MPC-37P, and MPC-44, the cooling time limit for the assembly shall be calculated based on the assembly burnup and the decay heat limit of the cell using the equation and appropriate coefficients in Section 2.5 of Appendix B of the CoC. For MPC-32ML, the cooling time limit for the assembly shall be calculated based on the assembly burnup using the equation and appropriate coefficients in Section 2.5 of Appendix B of the CoC. Regardless of the result of the equation, assemblies must meet the minimum cooling time requirements in Appendix B Table 2.1-1.

2. Ensure assemblies are characterized according to their condition, and that damaged fuel or fuel debris is either loaded into damaged fuel containers (DFCs), or, only for damaged fuel that can be handled by normal means, loaded in basket cells with DFI assemblies at the top and bottom of the cell.
3. Load the pre-selected fuel assemblies into the MPC in accordance with the approved loading plan.
4. Perform a post-loading visual verification of the assembly identification to confirm the serial numbers match the approved loading plan
5. If required, install fuel shims and/or DFI top caps where necessary in the cells.

Caution:
In accordance with the definition of "Undamaged Fuel," some low-enriched channeled fuel must be shown to be without known or suspected grossly breached spent fuel rods. This determination can be made based on review of records, fuel sipping, or other method.

9.2.4 MPC Closure

1. Install MPC lid and remove the HI-TRAC VW from the spent fuel pool as follows:

Note:
If the transfer cask is expected to be operated in an environment below 32 ºF, and a minimum heat load requirement was not applied to loading the MPC the water jacket shall be filled with an ethylene glycol solution (25% ethylene glycol). Otherwise, the jacket shall be filled with clean potable or demineralized water. Depending on weight limitations, the neutron shield jacket may remain filled (with pure water or 25% ethylene glycol solution, as required). Cask weights shall be evaluated to ensure that the equipment load limitations are not violated. (Not applicable for HI-TRAC VW Version V2).
Note (HI-TRAC VW :
HI-TRAC VW Version V2 contains utilizes the NSC Assembly for neutron shielding in lieu of a water jacket. The NSC contains Holtite-A for neutron shielding. Therefore operational~~s~~ steps involving a water jacket are not applicable to the HI-TRAC VW Version V2.

k. If previously drained, fill the neutron shield jacket with plant demineralized water or an ethylene glycol solution (25% ethylene glycol) as necessary.

l. Disconnect any special rigging from the MPC lid and disengage the lift yoke in accordance with site-approved rigging procedures.

Warning:
MPC lid dose rates are measured to ensure that dose rates are within expected values. Dose rates exceeding the expected values could be an indication that fuel assemblies not meeting the CoC have been loaded.

m. Measure the dose rates at the MPC lid and verify that the combined gamma and neutron dose is below expected values.

n. Perform decontamination and a dose rate/contamination survey of HI-TRAC.

o. If used, the HI-DRIP Cooling System may be installed and initiated.

Caution:
If used, the HI-DRIP system must be initiated no later than 50% of the time-to-boil duration.
Note:
The HI-DRIP system flow rate is established on a site-specific basis. See FSAR Section 4.5.7 for more information.

~~n.~~

~~o.~~p. Prepare the MPC annulus for MPC lid welding by removing the annulus seal and draining the annulus approximately 6 inches.

2. Prepare for MPC lid welding as follows:

applicable code and re-perform the NDE until the weld meets the required acceptance criteria.

4. Perform MPC lid-to-shell weld pressure testing in accordance with site-approved procedures.

5. ~~Repeat the liquid penetrant examination on the final pass of the MPC lid-to-shell weld~~Examine the MPC for leakage..

   a. In the event of leakage, ~~R~~repair any weld defects in accordance with the applicable code requirements and re-perform the NDE in accordance with approved procedures.

6. Drain the MPC and terminate time-to-boil monitoring and boron sampling program, where required.

ALARA Warning:
For operations involving HI-TRAC VW Version V2, the HI-TRAC VW shall be installed in the NSC prior to draining the water from the loaded MPC. The NSC contains Holtite-A shielding material to provide neutron shielding following drainage of water from the MPC
Note:
Detailed procedures for MPC drying are provided on a site-specific basis. The following summarize those procedures.

7. Dry and backfill the MPC (Vacuum Drying Method).

Note:
During drying activities, the annulus between the MPC and the HI-TRAC VW must be maintained full of water. Water lost due to evaporation or boiling must be replaced to maintain the water level.

   a. Fill the annulus between the MPC and HI-TRAC VW with clean water. The water level must be within 6” of the top of the MPC.

   ~~a.~~b. Stop HI-DRIP Cooling System, if used.

   ~~b.~~c. Attach the vacuum drying system (VDS) to the vent and drain port RVOAs. Other equipment configurations that achieve the same results may also be used.

Caution:
Rapidly reducing the pressure in the VDS piping and MPC while the system contains significant amounts of water can lead to freezing of the water and to improper conclusions that the system is dry. To prevent freezing of water, the MPC internal pressure should be lowered in a controlled fashion. The vacuum drying system pressure will remain at about 30 torr until most of the liquid water has been removed from the MPC. For HBF above a certain threshold, cyclic vacuum drying may be performed in accordance with Chapter 4 of this FSAR and ISG-11 Rev. 3.

a. Attach the moisture removal system to the vent and drain port RVOAs. Other equipment configurations that achieve the same results may also be used.

b. Drain the water from the annulus. For HI-TRAC VW Versions V and V2 keep the lower inflatable seal inflated to prevent cooling air flow through the annulus which extends the FHD drying times.

~~a.~~c. Stop the HI-DRIP Cooling System, if used.

~~b.~~d. Circulate the drying gas through the MPC while monitoring the circulating gas for moisture. Collect and remove the moisture from the system as necessary.

~~c.~~e. Continue the monitoring and moisture removal until LCO 3.1.1 is met for MPC dryness.

Note:
The demoisturizer module must maintain the temperature of the helium exiting the FHD below the Technical Specification limits continuously from the end of the drying operations until the MPC has been backfilled and isolated. If the temperature of the gas exiting the FHD exceeds the temperature limit, the dryness test must be repeated and the backfill re-performed.

~~d.~~f. Continue operation of the FHD system with the demoisturizer on.

~~e.~~g. While monitoring the temperatures into and out of the MPC, adjust the helium pressure in the MPC to provide a fill pressure as required by LCO 3.1.1.

~~f.~~h. Open the FHD bypass line and Close the vent and drain port RVOAs.

Warning:
A HI-TRAC VW Version V or V2 containing an MPC loaded with spent fuel assemblies shall NOT be left unattended to ensure that blockage of the air flow paths does not occur. The HI-TRAC vents shall be monitored to be free from blockage once every 4 hours.

~~g.~~i. For HI-TRAC VW Versions V and V2, deflate the lower inflatable annulus seal and remove the annulus shield to establish air flow through the annulus.

~~h.~~j. Shutdown the FHD system and disconnect it from the RVOAs.

~~i.~~k. Remove the vent and drain port RVOAs.

9. Weld the vent and drain port cover plates and perform NDE in accordance with the licensing drawings using approved procedures. Repair any weld defects in accordance with the applicable ~~code~~ Code and re-perform the NDE until the weld meets the required acceptance criteria.

a. If using redundant port cover plates, install the redundant port cover plate, perform the multi-pass welds, and perform NDE on the redundant port cover plates with

14. Place HI-STORM FW in storage as follows:

> **Note:**
>
> Closing the mating device drawer while the MPC is in the HI-STORM will block air flow. The mating device drawer shall remain open, to the extent possible, such that the open air path is at least as large as the HI-STORM Lid vent openings until the mating device is to be removed from the HI-STORM. When the mating device drawer is closed for mating device removal, the process shall be completed in an expeditious manner.

a. Remove the mating device.

~~a.~~b. Inspect the HI-STORM FW lid studs and nuts or lid closure bolts for general condition. Replace worn or damaged components with new ones.

> **Note:**
> Unless the lift has redundant drop protection features (or equivalent safety factor) for the HI-STORM FW lid, the lid shall be kept less than 2 feet above the top surface of the overpack. This is performed to protect the MPC lid from a potential HI-STORM FW lid drop.

~~b.~~c. Install the HI-STORM FW lid~~–~~, and if the HI-STORM anchor blocks are not utilized for cask movement, install the lid studs and nuts or lid closure bolts to secure the lid in place~~and the lid studs and nuts or lid closure bolts~~*.

~~c.~~d. Remove the HI-STORM FW lid lifting device and, if necessary, install the hole plugs* in the empty lift holes. Store the lifting device in an approved plant storage location.

> **Warning:**
> HI-STORM FW dose rates are measured to ensure they are within expected values. Dose rates exceeding the expected values could indicate that fuel assemblies not meeting the CoC may have been loaded.

~~d.~~e. Perform the HI-STORM FW surface dose rate measurements in accordance with the Technical Specifications. Measured dose rates must be compared with calculated dose rates that are consistent with the calculated doses that demonstrate compliance with the dose limits of 10CFR72.104(a).

~~e.~~f. Secure HI-STORM FW to the transporter device as necessary.

> **Note:**
> The site-specific transport route conditions must satisfy the requirements of the Technical Specification.

g. Perform a transport route walkdown to ensure that the transport conditions are met.

* Upon installation, studs, nuts, and threaded plugs shall be cleaned and inspected for damage or excessive thread wear (replaced if necessary) and coated with a light layer of Loctite N-5000 High Purity Anti-Seize (or equivalent).

~~ALARA Warning:~~ **ALARA Warning:**
Dose rates will rise around the gap between HI-STORM and ground when the loaded HI-STORM FW is lifted above the ground. Apply appropriate ALARA practices.

~~f.~~

~~g.~~h. Transfer the HI-STORM FW to its designated storage location at the appropriate pitch. If the lid studs and nuts or lid closure bolts are not installed, install them at this time to secure the lid to the cask body.

~~h.~~i. Attach the HI-STORM FW temperature elements (if used) and screens.

15. If required per CoC Condition #8 the user must perform the following annular air flow thermal test or cite a test report that was performed and prepared by another user.

    a. The annular air flow thermal test shall be conducted at least 7 days after the HI-STORM is loaded in order for the overpack to establish thermal equilibrium.

    b. The user or other qualified engineer shall calculate and record the actual heat load of the fuel stored in the HI-STORM.

    c. To minimize the effects on the annular air flow, the test shall be performed when the weather is relatively dry and calm. Additionally, the test can be performed indoors to help minimize effects on air flow.

    d. The ambient air temperature at the cask shall be recorded.

    e. For users loading up to, and including, CoC Amendment 1, Revision 1, test data shall be collected for the annular flow between the MPC and HI-STORM inner shell as follows:

        1. The outlet vent screen shall be removed from one outlet vent, if necessary for instrument access. Alternatively, if access ports have been provided in the HI-STORM lid, the access port plugs may be removed and access ports used for instrument access.

        2. A hot wire anemometer or similar flow measuring instrument shall be inserted into the annular space between the MPC and HI-STORM inner shell.

        3. The flow measuring instrument shall be at positioned at least 6” below the top of the MPC and shall not significantly block the air flow.

        4. The instrument shall not be placed too close to the MPC or HI-STORM shells to avoid edge effects on the flow.

        5. The outlet gamma shield and vent screen shall be re-installed if removed.

Table 9.2.1

HI-STORM FW SYSTEM ANCILLARY EQUIPMENT OPERATIONAL DESCRIPTION

Equipment	Important To Safety Classification*	Description
HI-STORM FW Lifting Jacks	Not Important To Safety	Jack system used for lifting the HI-STORM overpack to provide clearance for inserting or removing a device for transportation.
HI-DRIP Cooling System	Not Important To Safety	Optional ancillary used to prevent water in the loaded MPC from boiling during the interval between HI-TRAC removal from Spent Fuel Pool and MPC drying and backfilling.

2. Twelve storage cells (three in each quadrant) will be loaded with bayonet electric heaters each calibrated to deliver one kilowatt heat uniformly over its length. The heaters will be situated co-axially within each storage cell. Thus the heat generation in the MPC shall be quadrant-symmetric.
3. The top of the MPC shall be enclosed by an insulated lid. Calibrated thermocouples will be fastened to selected cell walls in each quadrant in a symmetric manner.
4. The test will be run for a sufficiently long time such that steady state conditions are reached. The ambient temperature and the thermocouple readings will be taken as specified in the test procedure.
5. The test condition will be simulated on the design basis FLUENT model of the MPC in Chapter 4 and the temperatures at all of the thermocouple locations predicted by FLUENT will be compared with the test data.
6. The amounts by which the FLUENT temperatures exceed the corresponding measured temperatures (positive margin) collectively define the margin of conservatism in the FSAR analysis model. A negative margin will warrant an immediate report to the NRC and appropriate licensing action pursuant to Holtec's QA program.

Following the loading and placement on the storage pad of the first HI-STORM system placed in service as specified in CoC Condition #8, the operability of the natural convective cooling of the HI-STORM FW system shall be verified by the performance of an air mass flow rate test. A description of the test is described in Chapter 9.

In addition, the technical specifications require periodic surveillance of the overpack air inlet and outlet vents or, optionally, implementation of an overpack air temperature monitoring program to provide continued assurance of the operability of the HI-STORM FW heat removal system.

10.1.7.1 Supplemental Cooling System Thermal Acceptance Testing

The following thermal acceptance testing shall be performed following fabrication and prior to the first implementation of the HI-DRIP Supplemental Cooling system. The thermal acceptance test will be performed and documented a single time for each method to validate the thermal analysis. (See also Section 2.2.1.g.)

10.1.7.1.1 HI-DRIP Supplemental Cooling Thermal Acceptance Testing

[

PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

PROPRIETARY INFORMATION WITHHELD PER 10CFR2.390

]

10.1.8 Cask Identification

Each MPC, HI-STORM overpack, and HI-TRAC transfer cask shall be marked with a model number, identification number (to provide traceability back to documentation), and the empty weight of the item in accordance with the marking requirements specified in 10 CFR 72.236(k).

12.1 OFF-NORMAL CONDITIONS

Off-normal operations, as defined in accordance with ANSI/ANS-57.9, are those conditions, which, although not occurring regularly, are expected to occur no more than once a year. In this section, design events pertaining to off-normal operation for expected operational occurrences are considered. The off-normal conditions are described in Subsection 2.2.2.

The following off-normal operation events have been considered in the design of the HI-STORM FW:

1. Off-Normal Pressure
2. Off-Normal Environmental Temperatures
3. Leakage of One Seal
4. Partial Blockage of Air Vents
5. Malfunction of FHD System
~~5.~~6. Power Failure in an Active Cooling System

For each event, the postulated cause of the event, detection of the event, analysis of the event effects and consequences, corrective actions, and radiological impact from the event are presented.

The results of the evaluations performed herein demonstrate that the HI-STORM FW System can withstand the effects of off-normal events and remain in compliance with the applicable acceptance criteria. The following subsections present the evaluation of the HI-STORM FW System for the design basis off-normal conditions that demonstrate that the requirements of 10CFR72.122 are satisfied, and that the corresponding radiation doses meet the requirements of 10CFR72.104(a) and 10CFR20, with appropriate margins.

12.1.1 Off-Normal Pressure

The sole pressure boundary in the HI-STORM FW System is the MPC enclosure vessel. The off-normal pressure condition is specified in Subsection 2.2.2. The off-normal pressure for the MPC internal cavity is a function of the initial helium fill pressure and the temperature reached within the MPC cavity under normal storage. The MPC internal pressure under the off-normal condition is evaluated with 10% of the fuel rods ruptured and with 100% of ruptured rods fill gas and 30% of ruptured rods fission gases released to the cavity.

12.1.1.1 Postulated Cause of Off-Normal Pressure

After fuel assembly loading, the MPC is drained, dried, and backfilled with an inert gas (helium) to assure long-term fuel cladding integrity during dry storage. Therefore, the probability of failure of intact fuel rods in dry storage is extremely low. Nonetheless, the event is postulated and evaluated.

12.1.5.4 Corrective Action for FHD Malfunction

The HI-STORM FW System is designed to withstand the FHD malfunction without an adverse effect on its safety functions. Consequently, no corrective action is required.

12.1.5.5 Radiological Impact of FHD Malfunction

The event has no radiological impact because the confinement barrier and shielding integrity are not affected.

12.1.6 Power Failure in an Active Cooling System

It is necessary to maintain the peak fuel cladding temperature below the ISG-11 Rev 3 limit under all Short- Term Operations. The HI-DRIP cooling system discussed in Section 4.5.7 is entirely passive and does not require an active system to render its safety function. Power failure for such passive systems is a *non sequitur*.

Table 1.I.1.1: Principle System Components QA Designation	
Principle System Components	**QA Designation**
HI-STORM FW UVH Overpack	ITS
HI-TRAC VW Transfer Casks (Table 1.I.1.2)	ITS
MPCs (Table 1.I.1.2)	ITS

Table 1.I.1.2 Principal Components Subject to Certification Associated with the Version UVH in the HI-STORM FW System			
Component I.D.	**Characteristic**	**Function**	**Comment**
MPC-37(Certified in Rev 0 of the CoC)	Storage for 37 PWR fuel assemblies	Provide confinement to its contents under normal, off-normal and accident conditions and during Part 72 Short Term operations	All MPC Fuel Baskets are made of Metamic-HT. Versions of these MPCs are listed in Table 1.0.1.
MPC-89 (certified in Rev 0 of the CoC)	Storage for 89 BWR fuel assemblies		
MPC-44 (Certification sought in Rev 7 of the CoC)	Storage for 44 PWR fuel assemblies		
HI-TRAC VW(certified in Rev 0 of the CoC), HI-TRAC VW Version V (certified in Rev 5 of the CoC), HI-TRAC VW Version V2 (certified in Rev 5 of the CoC)	Variable weight transfer cask available in unventilated and ventilated versions	The transfer cask is indispensable to execute Short Term operations.	Version UVH is configured to utilize the same HI-TRAC models as other "FW" overpack models.

the cask body by a set of equally spaced anchor bolts with a small clearance and an interposed gasket providing a barrier against intrusion of air in the overpack's annulus space and thus protecting the MPC from the deleterious effect of airborne species that induce stress corrosion cracking (SCC) in stainless steel. Precluding the incidence of SCC in the MPC shell during extended period of storage by creating a still air environment around it is a principal benefit of Version UVH. The weight of the Closure Lid helps the sealing action of the gasket. In the event the air in the overpack annulus were to pressurize, the weight of the lid is counteracted allowing the air to escape. Thus, the overpack has a built-in protection against overpressure.

In addition to providing a barrier against ingress of aggressive species in the space around the MPC, Version UVH also accrues several salutary benefits, such as:

- Absence of vent openings eliminates a source of radiation to the environment emitted from the Canister.
- The overpack is rendered much more rugged against mechanical projectiles in absence of vent openings. The intermediate and penetrant Design Basis Missiles (see Table 2.I.2.1) cease to be a safety concern.
- The Version UVH overpack, made of steel and devoid of any vents, emulates a metal cask in respect of critical functions under accident conditions such as the Design Basis Fire. However, thanks to its larger footprint and greater mass, it is a far superior in respect of shielding capacity and seismic stability in comparison to any peer metal cask.
- The aging related deterioration of the paint on the cask's internal surface is substantially retarded because of the hot and dry environment in contact with it.
- The need for periodic inspection of the vent openings and associated LCOs in the CoC becomes inoperative eliminating this source of radiation dose to the site staff.

Because of the main heat rejection path in Version UVH is conduction through the cask body, a large number of ribs are used to join the inner and outer shells. Likewise, the Closure lid features extensive physical connectivity between its bottom and top surfaces.

In summary, Version UVH overpack emulates a conventional metal cask but provides significantly improved radiation shielding because of its thick and high density concrete filled steel weldment construction. Its other notable characteristics are:

- There is considerable flexibility relative to the height of the cask's internal cavity as well. The cavity should be tall enough to accommodate the tallest MPC that will be stored at the site.
- The density of the shielding concrete can be set at the value needed within the allowable range in Table 1.I.2.1~~(between 200 and 250 pcf)~~ to realize the level of dose reduction required.

1.I.2.1.3 Transfer Cask

No new transfer cask design is proposed in this supplement and existing design described in Subsection 1.2.1.3 is not modified.

1.I.2.1.4 Shielding and Neutron Absorber Materials:

There is no change in the materials employed in the HI-STORM FW system with Version UVH overpack.

1.I.2.1.5 Lifting Devices:

There is no change in the specification for the Lifting Devices described in the HI-STORM FW system as described in subsection 1.2.1.5 in the main report.

1.I.2.1.7 Design Life:

There is no change in the design life of the HI-STORM FW system as described in the main body of this FSAR.

TABLE 1.I.2.1
THERMAL AND SHIELDING SIGNIFICANT SYSTEM DATA

Item	Property	Value
Concrete in HI-STORM FW Version UVH overpack body and lid	Installed Nominal Density (lb/ft^3)	200 (minimum) 250 (maximum)

1.I.2.2 Operational Features:

The operational features remain fully applicable except that, as stated in Chapter 9.I, before installing the Closure Lid on the Storage overpack, a gasket to inhibit exchange of the gas inside and outside of the cask is placed on the interface between the cask body and the Closure Lid.

1.I.2.2.3 Identification of Subjects for Safety and Reliability Analysis

1.I.2.2.3.1 Criticality Prevention

There is no change in the MPCs, and their Fuel Baskets proposed in this Supplement. Therefore, there is no change in the criticality safety characteristics of the Storage system.

1.I.2.2.3.2 Chemical Safety

As stated in 1.2.2.3.2, there are no chemical safety hazards associated with operations of the Storage system. A detailed evaluation is provided in Section 3.4.

1.I.2.2.3.3 Operation Shutdown Modes

The Storage system is totally passive and consequently, operation shutdown modes are unnecessary.

1.I. 2.2.3.4 Instrumentation

As stated in 1.2.2.3.4, the HI-STORM FW MPC, which is seal welded, non-destructively examined, and pressure tested, confines the radioactive contents. The Storage system is completely passive with appropriate margins of safety; therefore, it is not necessary to deploy any instrumentation to monitor the

CHAPTER 2.I: PRINCIPAL DESIGN CRITERIA

2.I.0 Introduction:

The principal design criteria for the Version UVH equipped HI-STORM FW Canister storage system is unchanged in all respects except for those relating to environment control and annulus overpack pressure.

The Version UVH overpack does not have any open penetrations such as air vents in the classical design to permit ventilation of the ambient air. All open vents are eliminated, and the Closure Lid is installed with a concentric gasket which inhibits the exchange of the gas inside the cask with the ambient air. ~~The air in the cask cavity space is filled to a sub-atmospheric pressure to ensure that the internal pressure during operating conditions will always remain below the external ambient pressure, precluding any release of the cavity gas into the ambient.~~ The Closure Lid is emplaced on the cask body with body bolts which are installed with a small axial clearance to allow any significant increase in internal gas pressure above the ambient, under hypothetical scenarios, to be relieved once it overcomes the counteracting lid's weight. A simple force equilibrium shows that a pressure rise of 5 psi in the cask cavity is not possible to sustain even under the scenario of maximum density concrete installed in the cask's lid. However, the structural evaluations are performed by conservatively assuming that the internal pressure is not relieved under hypothetical accident conditions.

The loadings associated with Version UVH must include internal pressure and external pressure which are not present in the ventilated cask. For all other Design Basis Loadings, Version UVH cask body is the same as the standard FW or Version E cask body. In this chapter, the Design pressures appropriate to Version UVH are defined and the overpack loadings are re-visited to ensure that the safety analyses presented in other chapters are comprehensive.

2.I.0.1 Principal Design Criteria for the ISFSI Pad

The principal design criteria for the ISFSI pad applicable for the Version UVH cask remains unchanged from the main body of the FSAR (Table 2.2.9) with the exception of the requirements identified in Table 2.I.0.1.

Table 2.I.2.3; Pressure Loadings for the Version UVH Canister Storage Cask		
Loading	**Value, psig**	**Comment**
Design Basis Minimum Internal Pressure	-14.7	Corresponds to full vacuum
Design Basis Maximum Internal Pressure	10 [Note 1]	Bounding internal pressure under normal and off-normal conditions.
Accident External Pressure	60	Bounding steady state pressure assumed to act on all external surfaces of the overpack
Accident Internal Pressure	15	Bounding internal pressure under hypothetical conditions
Note 1: The approximate lid lift-off pressure is 2.5 psig. See Section 2.I.0.		

Therefore, following this strategy, several regionalized patterns for MPC-37 and MPC-89 are identified and evaluated using 3-D Computational Fluid Dynamics (CFD) models (Section 4.I.4.2).

4.I.1.4 Backfill Pressure Limits

The minimum and maximum initial helium backfill pressures for MPCs stored in Version UVH system are listed in Table 4.I.1.3. The maximum annulus fill pressure is computed such that the annulus maximum operating pressure under all conditions of storage is lower than the design basis maximum internal pressure specified in Table 2.I.2.3. Detailed methodology to compute the annulus initial fill pressure limits is provided in Section A.6.3 of [4.I.1].

~~The air annulus between the MPC and the Version UVH overpack is backfilled such that the annulus air design pressure as specified in Table 4.I.1.3 is satisfied.~~

Table 4.I.1.3 INITIAL BACKFILL PRESSURE LIMITS FOR MPC HELIUM AND ANNULUS AIR PRESSURE		
Condition	MPC Helium Backfill Pressure Limits (psig)	Annulus Initial Air Fill Pressure Limit (psig)~~Annulus Air Design Pressure (psig)~~
MPC-37	42.0 – 45.5 @70ºF	See Section 4.I.1.4 Note 1 ~~10 psig~~ ~~10 psig~~ ~~10 psig~~
MPC-44	41.0 – 44.0 @70ºF	
MPC-89	42.5 – 46.5 @70ºF	
Note 1: An initial annulus fill pressure of 0 psig at a reference temperature of 70ºF is used for the licensing basis calculations.		

Table 4.I.4.2 SUMMARY OF MPC CAVITY AND HI-STORM UVH ANNULUS PRESSURES UNDER NORMAL STORAGE CONDITIONS FOR THE MOST BOUNDING CONFIGURATION Note 1	
Condition	**MPC-37 (psig)**
MPC - Normal (Intact rods) - 1% rods rupture	 97.0 98.1
HI-STORM FW UVH Annulus - Initial fill Pressure - Maximum Normal Operating Pressure ~~HI-STORM FW UVH Annulus~~	0 8.84 Note 2 ~~8.84~~
Note 1: 10% and 100% rod ruptures lead to release of significant amount of fission gases into the cavity, leading to an increase in the thermal conductivity of the cavity space. Since the MPC internal pressures under normal storage conditions for MPC-37, MPC-44, and MPC-89 in Version UVH [4.I.1] are bounded by those for MPC-37 in standard HI-STORM FW as reported in the main chapter, MPC pressure under off-normal and accident conditions will also be bounded by that for MPC-37 in standard HI-STORM FW. Note 2: The design basis maximum internal pressure, specified in Table 2.I.2.3, is based on structural analyses. However, the annulus lid lifts off to vent excess air, as described in Section 1.I.2, at a lower pressure specified in Table 2.I.2.3. This restores the annulus back to the lid lift-off pressure. The evaluations and results presented here are a defense-in-depth demonstration that the structural design limits set forth in Table 2.I.2.3 are satisfied, even in the absence or malfunction of the pressure venting mechanism.	

TABLE 4.I.6.1 RESULTS FOR DESIGN BASIS FIRE EVENT FOR THE MOST BOUNDING MPC-37/VERSION UVH SCENARIO	
Component	Temperature, °C (°F)
Fuel Cladding	376 (709)
Basket	354 (669)
MPC Shell	264 (507)
MPC Lid	265 (509)
MPC Baseplate	238 (460)
Pressure, psig	
MPC Cavity	99.0
HI-STORM FW UVH Annulus	9.09 [Note 1]
Note 1: The accident internal pressure, as specified in Table 2.I.2.3, is based on structural analyses under accident conditions. However, as presented in Supplement 1.I, the annulus lid lifts off to vent off excess air, as described in Section 1.I.2, at a lower pressure specified in Table 2.I.2.3. This restores the annulus back to the "lid lift-off" pressure. The evaluations and results presented here are a defense-in-depth demonstration that the structural design limits set forth in Table 2.I.2.3 are satisfied, even in the absence or malfunction of the pressure venting mechanism.	

TABLE 4.I.6.2 RESULTS FOR EXTREME AMBIENT TEMPERATURE CONDITION FOR THE MOST BOUNDING MPC-37/VERSION UVH SCENARIO	
Component	Temperature, ºC (ºF)
Fuel Cladding	393 (740)
Basket	372 (701)
MPC Shell	283 (541)
MPC Lid Note 1	287 (548)
MPC Baseplate Note 1	253 (487)
Pressure, psig	
MPC Cavity	103.1
HI-STORM FW UVH Annulus	10.39 Note 2
Note 1: Maximum section average temperature is reported Note 2: The accident internal pressure, as specified in Table 2.I.2.3, is based on structural analyses under accident conditions. However, as presented in Supplement 1.I, the annulus lid lifts off to vent off excess air, as described in Section 1.I.2, at a lower pressure specified in Table 2.I.2.3. This restores the annulus back to the "lid lift-off" pressure. The evaluations and results presented here are a defense-in-depth demonstration that the structural design limits set forth in Table 2.I.2.3 are satisfied, even in the absence or malfunction of the pressure venting mechanism.	

5.I.3 MODEL SPECIFICATIONS

The shielding analysis of the HI-STORM FW UVH system was performed with MCNP5 [5.1.1], which is the same code used for the analyses presented in the main part of this chapter. A sample input file for MCNP is provided in Appendix 5.I.A.

Section 1.I.5 provides the drawings that describe the HI-STORM FW UVH system. These drawings, using nominal dimensions, were used to create the MCNP models used in the radiation transport calculations. Modeling deviations from these drawings are discussed below. Figures 5.I.3.1, 5.I.3.2 and 5.I.3.3 show cross sectional views of the HI-STORM FW UVH overpack, MPCs, and basket cells as they are modeled in MCNP. Figures 5.I.3.1, 5.I.3.2 and 5.I.3.3 were created in VISED and are drawn to scale.

Composition and densities of the various materials used in the HI-STORM FW UVH system and HI-TRAC shielding analyses are given in Section 5.3.2 in the main part of the report. A minimum ~~3.2 g/cm^3 (200 pcf)~~ concrete density is required for HI-STORM FW UVH for enhanced thermal conductivity as specified in Table 1.I.2.1 and Table 1.D.1 in Appendix 1.D of Reference [5.2.17]. Conservatively, 2.72 g/cm^3 (170 pcf) concrete density is used in the dose rates analysis in this Supplement. Concrete composition and density for HI-STORM FW UVH system is shown in Table 5.I.3.1.

Since the HI-STORM FW UVH model uses principally the same MPC model as the calculations in the main body of this chapter, all figures, conservative modeling approximations, and modeling differences for the MPC shown in Section 5.3 are applicable to the calculations in this supplement. The differences between models and drawings for the module are listed and discussed here.

1. The MPC supports and guides were conservatively neglected.
2. The fuel shims are not modeled This is conservative since it removes steel that would provide a small amount of additional shielding.
3. The thickness of HI-STORM lid concrete is 14 inches. It is conservatively modelled as 13.75 inches.
4. Ribs of HI-STORM lid above the cover plate are not modelled. This conservatively reduces the amount of steel in the lid.

9.I.2 PROCEDURE FOR LOADING THE HI-STORM FW UVH SYSTEM IN THE SPENT FUEL POOL

The procedures presented within Subsections 9.2.1 through 9.2.5 of Chapter 9 are identical for the HI-STORM FW UVH system. The changes to operations when placing the HI-STORM FW UVH into storage are described below.

9.I.2.6 Placement of HI-STORM FW UVH into Storage

The following instructions shall be incorporated to the cask operations as additional steps to the generic guidance in Section 9.2.6 on loading operations for unventilated cask models in Chapter 9:

1. After Step 2, prior to Step 4:

    a. Inspect cask cavity and confirm to be visibly dry (free of standing water).

2. After Step 14.b, prior to Step 14.c:

    a. Before installing the Closure Lid on the cask body, the lid gasket is placed on the top of the cask's top ring.

    b. Remove drain assembly plugs to prevent pressurization of cavity during HI-STORM transfer operations.

3. Perform Step 14.c, taking care not to damage the gasket.

4. After Step 14.h:

    1. Tighten lid hex nuts to the point of contact with the washer. Then loosen nut to provide a nominal axial gap of 0.5".

Note:
The HI-STORM FW UVH cavity initial pressure is adjusted as necessary in accordance with Section 4.I.1.4.

    2. Reinstall the drain assembly plugs.

~~1. Before installing the Closure Lid on the cask body, the lid gasket is placed on the top of the cask's top ring.~~

~~2. Inspect cask cavity and confirm to be visibly dry (free of standing water).~~

3. ~~Place cask lid on top of the gasket.~~

4. ~~Continue with the steps of Subsection 9.2.6 of Chapter 9 for conducting the required surface dose rate measurements in accordance with the Technical Specification and movement of the overpack to its storage location on the ISFSI pad.~~

5. ~~After the cask is placed in its storage location on the ISFSI pad, install lid studs, washers, and hex nuts onto the cask.~~

6. ~~Tighten lid hex nuts to the point of contact with the washer. Then loosen nut to provide a nominal axial gap of 0.5".~~

7. ~~If the site is using non-oxidizing gas in place of air in the annulus, evacuate air in the MPC/HI-STORM FW UVH annulus and replace with dry nitrogen (or another non-oxidizing gas) using couplings provided in the small penetrations in the cask body. The target fill pressure of the non-oxidizing fill gas shall be determined on a site-specific basis to meet the design pressure indicated in Table 4.I.1.3.~~

Table 9.I.2.3 HI-STORM FW UVH SYSTEM OVERPACK INSPECTION CHECKLIST
Note: This checklist provides a supplement to the main table 9.2.3 as a basis for establishing additional steps to a site-specific inspection checklist for the HI-STORM FW UVH overpack. Specific findings shall be brought to the attention of the appropriate site organizations for assessment, evaluation, and potential corrective action prior to use.

HI-STORM FW UVH Overpack Lid:

1. Lid sealing surfaces shall be cleaned and inspected for corrosion, scratches, and gouges.
2. Lid seal shall be inspected for cuts, abrasions, or other damage which may affect is function.
3. Vent and vent screen inspections are not required because the HI-STORM FW UVH lid does not include vents.

HI-STORM FW UVH Main Body:

1. Vent and vent screen inspections are not required because the HI-STORM FW UVH body does not include vents.

CHAPTER 12.I: OFF-NORMAL AND ACCIDENT EVENTS

12.I.0 Introduction

In this chapter, the off-normal and accident events germane to the HI-STORM FW UVH system are considered. Because no new MPC or transfer cask are introduced in Chapter I, the off-normal and accident events applicable to them remain unchanged and therefore, are not required to be evaluated herein. Furthermore, events resulting from vent openings in the overpack are also not applicable for the ventless UVH overpack. Finally, a survey of the regulatory literature shows that the unvented overpack does not introduce any new off-normal or accident event of safety consequence[1]. Therefore, the number of events that merit consideration in this chapter is vastly reduced. Those events that are applicable to the unvented overpack are evaluated in the following.

[1] The case of leakage of the gasket in the overpack is included even though it is not a safety significant event.

TABLE 12.I.1

ACCIDENT CONDITION EVENTS

Event	**Location in the main report**	**Comment (Cases that are italicized have been determined to require complete evaluation which is provided in the subsections above)**
Overpack handling accident	12.2.2	The unvented overpack has the same handling characteristics as the vented type. Therefore, the discussion in subsection 12.2.2 applies.
Non-mechanistic tip-over	12.2.3	The unvented overpack has the same lateral impact characteristics as the vented type. Therefore, the discussion in subsection 12.2.3 applies
Design Basis Fire	*12.2.4*	*This condition requires additional evaluation because the unvented overpack is thermally more conductive and hence more responsive to fire.*
Tornado borne missiles	12.2.6	The unvented overpack has improved tornado missile resistance in the absence of vent openings. Therefore, the safety justification in subsection 12.2.6 applies.
Design Basis Flood	12.2.7	A vulnerability in the vented models, the unvented overpack does not suffer from a deleterious scenario such as "smart flood". Furthermore, the heat rejection rate to the flood waters will be greater. Therefore, a flood event does not challenge the safety performance of the Storage System containing an unvented overpack.
Earthquake	12.2.8	The discussion and approach to deal with earthquake in Chapters 2, 3 and 12 applies to the unvented overpack-bearing storage system without any modification.
Explosion	12.2.11	The discussion and approach to deal with an explosion event, discussed in subsection 12.2.11, applies to the unvented overpack-bearing storage system. In addition, the discussion in Section 2.I.2 regarding AEP is applicable.
Lightning	12.2.12	As discussed in subsection 12.2.12, lightning is an inconsequential event to the Storage System.
Burial-under-debris	12.2.14	Since the standard HI-STORM FW is primarily cooled by ventilation while the Version UVH system is not, a burial-under-debris accident will have a much more significant impact on the temperatures for the standard version. A standard HI-STORM FW without ventilation is thermally equivalent to the Version UVH system. Since the maximum allowable heat load for Version UVH system is significantly lower than that for the standard version, therefore, the evaluation for the standard version bounds that for Version UVH.
Extreme Environmental Temperature	12.2.15	The consideration of elevated off-normal temperature in subsection 12.I.1.1 in the foregoing applies without any change to the accident condition case.